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Tank Characterization Report for Double-Shell Tank 241-AP-108

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Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-AP-108. This reports supports the requirements of Tri-Party Agreement Milestone M-44-09.

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Tank Characterization Report for Double-Shell Tank 241-AP-108

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EXECUTIVE SUMMARY

This characterization report summarizes the available information on the historical uses, current status, and sampling and analysis results of Hanford Site underground storage tank 241-AP-108. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-09 (Ecology et al. 1996).

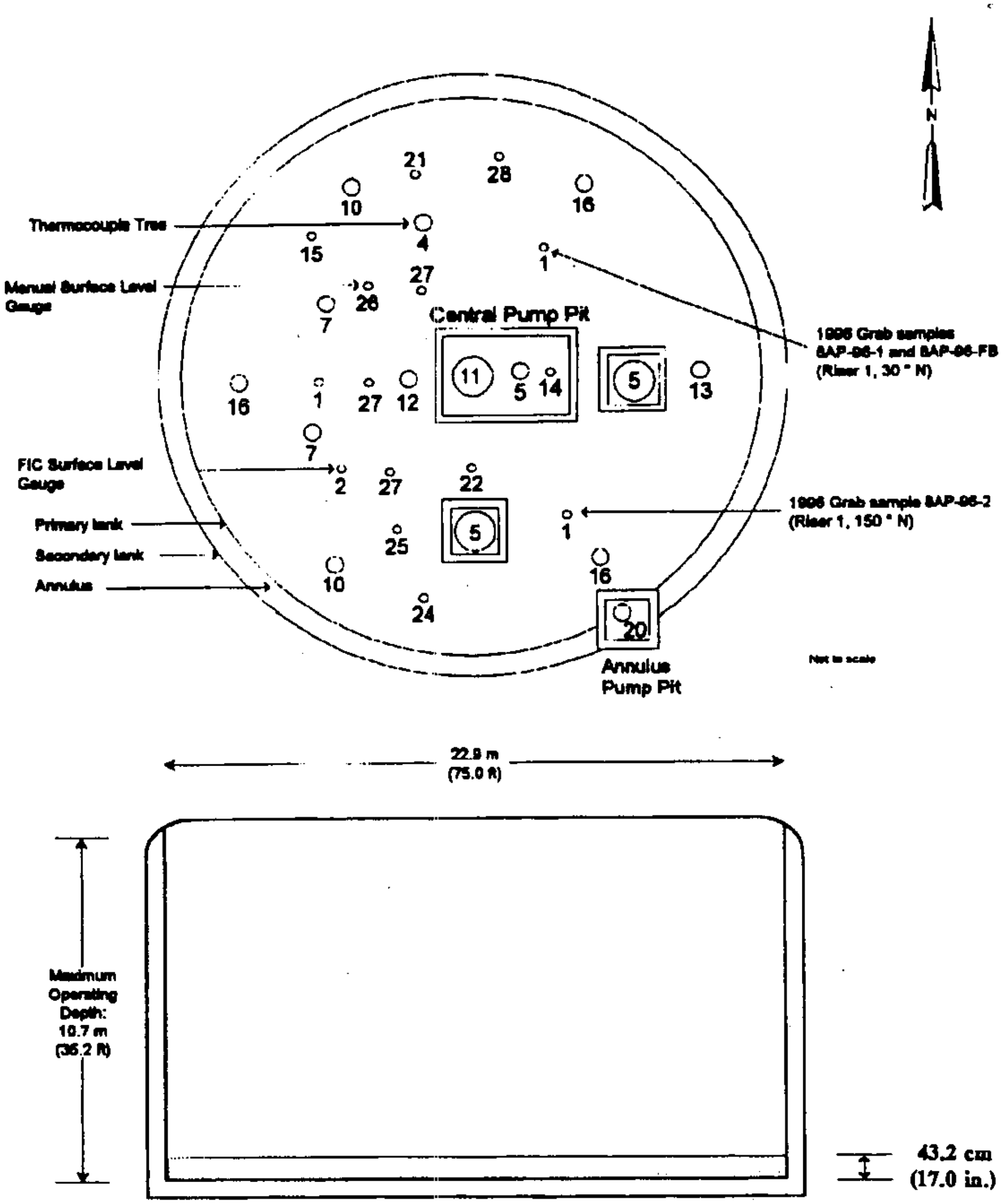
Tank 241-AP-108 is one of eight double-shell tanks located in the Hanford Site 200 East Area AP Tank Farm. The first waste stream received by the tank was plutonium-uranium extraction (PUREX) ammonia scrubber feed during the first quarter of 1990. The tank received several transfers of dilute non-complexed waste from miscellaneous PUREX sources between the first quarter of 1991 and the second quarter of 1992. The total amount of this waste transferred was 348 kL (92 kgal). A transfer from tank 241-AY-102 to tank 241-AP-108 occurred during the fourth quarter of 1991. The particular type of waste transferred is not known for certain, but it was probably B Plant low-level waste and a smaller quantity of decontamination waste of unknown origin. Tank transfers were confined to non-complexed waste and the tank was originally designated a non-complexed waste receiver tank. On April 19, 1996 and June 19, 1996 dilute complexed waste from B Plant was transferred into the tank. Tank AP-108 has been classified as a complexed waste receiver tank.

A description of the tank and its status is presented in Table ES-1, and a plan view schematic and profile of tank 241-AP-108 are provided in Figure ES-1. The tank has an operating capacity of 4,390 kL (1,160 kgal), and presently contains an estimated 178 kL (47 kgal) of dilute complexed waste, all of which is supernatant.

Table ES-1. Description and Status of Tank 241-AP-108.

TANK DESCRIPTION		
Type		Double-shell
Constructed		1983-1986
In-service		July 1986
Diameter		22.9 m (75.0 ft)
Operating depth		10.7 m (35.2 ft)
Capacity		4,390 kL (1,160 kgal)
Bottom shape		Flat
Ventilation		Active
TANK STATUS		
	January 1, 1996	June 20, 1996
Waste classification	Dilute non-complexed	Dilute complexed
Total waste volume	106 kL (28 kgal)	178 kL (47 kgal)
Sludge volume	0 kL (0 kgal)	0 kL (0 kgal)
Supernatant volume	106 kL (28 kgal)	178 kL (47 kgal)
Waste surface level (April 1996)	0.274 m (10.8 in.)	0.432 m (17.0 in.)
Temperature (June 1995 to April 1996)	6.1 °C (43 °F) to 41.7 °C (107 °F)	
Integrity		Sound
Watch List		None
SAMPLING DATES		
Grab samples and tank headspace flammability		January 1996
SERVICE STATUS		
In service		1986 to Present

Figure ES-1. Profile of Tank 241-AP-108.



Total Tank Volume: 4,390 kL (1,160 kgal)
Current Waste Volume (June 1996): 178 kL (47 kgal)
Supernatant Volume (June 1996): 178 kL (47 kgal)
Sludge Volume (June 1996): 0 kL (0 kgal)

This report summarizes the collection and analysis of two grab samples that were acquired in January 1996 and reported in the *Revised Final Report for Tank 241-AP-108, Grab Samples 8AP-96-1, 8AP-96-2, and 8AP-96-FB* (Esch 1996). One supernatant grab sample (8AP-96-1) and one field blank (8AP-96-FB) were taken through riser 1 at 30° N, and one supernatant grab sample (8AP-96-2) was taken through riser 1 at 150° N. ~~The sampling event~~ was performed to satisfy the requirements listed in the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995). The sampling and analyses were conducted in accordance with the *Tank 241-AP-108 Grab Sampling and Analysis Plan* (Baldwin 1996). The safety screening data quality objective (DQO) requires analyses for fuel energy value using differential scanning calorimetry (DSC), total alpha activity through alpha proportional counting or fissiles and neutron absorbers, and bulk density measurement by centrifugation. The safety screening DQO also requires a determination of gas composition (the lower flammability limit [LFL]) of the tank headspace gases. To satisfy this requirement, vapor samples were taken prior to grab sampling, and flammability was measured as a percentage of the LFL using a combustible gas meter. The waste compatibility DQO required analyses for energy, percent water, and density, as well as total inorganic carbon (TIC), total organic carbon (TOC), pH, selected cations, anions, and radionuclides, and a visual check for the presence of an organic layer.

Decision criteria thresholds were established by the safety screening DQO for the three primary analytes: DSC, total alpha activity, and tank headspace gas composition. Comparisons were made between these limits and the analytical results. No exothermic reactions were observed during the DSC analysis. The total alpha activity was below the detection limit. Finally, the concentration of flammable gases in the tank headspace was 0 percent of the LFL, well below the limit of 25 percent of the LFL. Thus, the analytical results were all below the parameters listed in the safety screening DQO indicating that tank 241-AP-108 is safe.

Comparisons were also made between the analytical results and the safety and operational decision thresholds of the waste compatibility DQO. All results satisfied their respective safety criteria. The operational analytical requirements were met, and additional requirements for waste transfers are given in the DQO.

The tank heat load estimate based on the 1996 data was 9.79 W (33.4 Btu/hr). The average thermocouple reading in the headspace above the waste for July 1989 through April 1996 was 21 °C (70 °F).

Table ES-2 provides concentration and inventory estimates for the most prevalent analytes and analytes of concern based on the 1996 grab sampling analyses.

Table ES-2. Major Analytes and Analytes of Concern.[1]

Analyte	Overall Mean Concentration	RSD (Mean)	Projected Inventory
METALS	**μg/mL**	**%**	**kg**
Aluminum	1,070	1.9	113
Sodium	17,400	3.6	1,840
ANIONS	**μg/mL**	**%**	**kg**
Hydroxide	2,770	0.5	294
Nitrate	14,800	1.2	1,570
Nitrite	3,730	0.3	395
RADIONUCLIDES	**μCi/mL**	**%**	**Ci**
^{137}Cs	19.5	0.8	2,070
$^{89/90}Sr$	0.0311	9.4	3.30
PHYSICAL PROPERTIES			
Wt% water	93.0 %	0.3	1.01E+05
Specific gravity	1.02 g/mL	0.2	

Notes:

RSD (Mean) = relative standard deviation of the mean.

[1]Esch (1996)

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LIST OF TERMS

ANOVA	analysis of variance
Btu/hr	British thermal units per hour
CASS	Computer Automated Surveillance System
Ci	curies
Ci/g	curies per gram
Ci/L	curies per liter
cm	centimeter
DQO	data quality objective
DSC	differential scanning calorimetry
FIC	Food Instrument Corporation
ft	feet
gal	gallons
g	grams
g/gal	grams per gallon
g/L	grams per liter
g/mL	grams per milliliter
GEA	gamma energy analysis
HDW	Hanford Defined Waste
HTCE	Historical Tank Content Estimate
in.	inches
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
J/g	joules per gram
kg	kilograms
kg C	kilograms carbon
kgal	kilogallons
kL	kiloliters
kW	kilowatts
LEL	lower explosive limit
LFL	lower flammability limit
L	liters
m	meters
$\underline{M}$	moles per liter
mL	milliliters
mm	millimeters
mrad/hr	millirads per hour
ppm	parts per million
PUREX	plutonium-uranium extraction
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation

LIST OF TERMS (Continued)

SACS	Surveillance Analysis Computer System
SAP	sampling and analysis plan
SU	supernatant
TGA	thermogravimetric analysis
TIC	total inorganic carbon
TLM	Tank Layer Model
TOC	total organic carbon
TRU	transuranic
W	watts
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
μg C/mL	micrograms carbon per milliliter
μCi/g	microcuries per gram
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg/g	micrograms per gram
μg/mL	micrograms per milliliter

1.0 INTRODUCTION

This tank characterization report presents an overview of Hanford Site double-shell tank 241-AP-108 and its contents. It provides estimated concentrations and inventories for the waste components based on the latest sampling and analysis activities, in combination with background tank information. The characterization of tank 241-AP-108 is based on the results of two grab samples taken in January 1996. For informational purposes, results from a 1994 sampling event have also been presented.

Tank 241-AP-108 is still in service and may continue to transfer or receive waste. Consequently, the composition of the tank waste may change depending on the waste types received. The analyte concentrations reported in this document reflect the best available information of the tank's contents based on the analytical data from the most recent sampling event. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* Milestone M-44-09 (Ecology et al. 1996).

1.1 PURPOSE

The purpose of this report is to summarize the information about the use and contents of tank 241-AP-108. Where possible, this information will be used to assess issues associated with safety, operations, environmental, and process development activities. This report also serves as a reference point for more detailed information concerning tank 241-AP-108.

1.2 SCOPE

The January 1996 grab sampling event for tank 241-AP-108 supported the evaluation of the tank waste according to the safety screening and waste compatibility data quality objectives (DQOs). The sampling and analysis plan (SAP) (Baldwin 1996) summarized the requirements of these two DQOs and directed that the following analyses be performed: DSC (to evaluate fuel level and energetics); TGA (to determine moisture content); total alpha activity analysis (to evaluate criticality potential); inductively coupled plasma spectroscopy (ICP) (for aluminum, iron, and sodium); ion chromatography (IC) (for chloride, fluoride, nitrate, nitrite, phosphate, and sulfate); titration (for hydroxide); furnace oxidation (for TIC and TOC); alpha proportional counting (for ^{241}Am and $^{239/240}$Pu); gamma energy analysis (GEA) (for ^{137}Cs); beta proportional counting (for $^{89/90}$Sr); pH; specific gravity; centrifugation (for percent solids); and a visual check for an organic layer. In addition to these analyses conducted on the grab samples, the tank headspace was sampled for the presence of flammable gases per the safety screening DQO. The sampling event was focused on the verification of the non-Watch List status of the tank and determination of whether any immediate or special concerns regarding non-routine waste transfers were warranted.

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2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-AP-108 based on historical information. The first part details the current condition of the tank. The next part discusses the tank's design, transfer history, and the process sources that contributed to the tank waste, including an estimate of the current contents based on the process history. Events that may be related to tank safety issues, such as potentially hazardous tank contents or off-normal operating temperatures, are included. The final part summarizes available surveillance data for the tank. Solid and liquid level data are used to determine tank integrity (leaks) and to provide clues to internal activity in the solid layers of the tank. Temperature data are provided to evaluate the heat-generating characteristics of the waste.

2.1 TANK STATUS

As of January 1996, at the time of the latest sampling event, tank 241-AP-108 contained an estimated 106 kL (28 kgal) of waste classified as dilute non-complexed (Hanlon 1996). Liquid waste volume was estimated using both a surface-level gauge and manual tape. The amounts of various waste phases existing in the tank are presented in Table 2-1.

Table 2-1. Estimated Tank Contents as of January 1996.[1,2]

Waste Form	Estimated Volume	
	kL	kgal
Total waste	106	28
Supernatant liquid	106	28
Drainable interstitial liquid	0	0
Drainable liquid remaining	106	28
Pumpable liquid remaining	106	28
Sludge	0	0
Saltcake	0	0

Note:

[1]Hanlon (1996)

[2]AP-108 is an active tank. Complexed waste was added to the tank in April and June of 1996 increasing the estimated volume to 178 kL (47 kgal).

Tank 241-AP-108 is categorized as sound and is not on any Watch List. This tank is actively ventilated. All monitoring systems were in compliance with documented standards as of January 1996 (Hanlon 1996).

2.2 TANK DESIGN AND BACKGROUND

The 241-AP Tank Farm was constructed from 1983 to 1986 in the 200 East Area. The 241-AP Tank Farm contains eight double-shell tanks. These tanks have a capacity of 4,390 kL (1,160 kgal), a diameter of 22.9 m (75.0 ft), and an operating depth of 10.7 m (35.2 ft). Tank 241-AP-108 entered service in July 1986, but did not receive waste until the first quarter of 1990. These tanks were designed to hold boiling waste with a maximum design temperature of 149 °C (300 °F) (Brevick et al. 1995a).

Tank 241-AP-108 was constructed with a primary carbon steel liner (heat-treated and stress-relieved), a secondary carbon steel liner (not heat-treated), and a reinforced concrete shell. The bottom of the primary liner is 13 mm (0.5 in.) thick, the lower portion of the sides is 19 mm (0.75 in.) thick, the upper portion of the sides is 13 mm (0.5 in.) thick, and the dome liner is 9.5 mm (0.375 in.) thick. The secondary liner is 9.5 mm (0.375 in.) thick. The concrete walls are 460 mm (1.5 ft) thick and the dome is 380 mm (1.25 ft) thick. The tank has a flat bottom. The bottoms of the primary and secondary liners are separated by an insulating concrete layer. A grid of drain slots in the concrete foundation beneath the secondary steel liner collects any waste that may leak from the tank and diverts it to the leak detection well.

Tank 241-AP-108 has 29 risers ranging in diameter from 100 mm (4 in.) to 1.1 m (42 in.) that provide access to the tank and 42 risers that provide access to the annulus. Table 2-2 shows numbers, diameters, and descriptions of the risers (annular risers not included). A plan view that depicts the riser configuration is shown as Figure 2-1. Seven 100-mm (4-in.)-diameter risers (nos. 15, 21, 24, 28, and three no. 27's), four 300-mm (12-in.)-diameter risers (nos. 7, 12, and two no. 10's), and two 1.1-m (42-in.)-diameter risers (two no. 5's) are available for use to reach the tank interior. Figure 2 is a tank cross-section that shows the approximate waste level and a schematic of the tank equipment.

Table 2-2. Tank 241-AP-108 Risers.[1,2,3] (2 sheets)

Riser Number[4]	Diameter (Inches)	Description and Comments
1 @ 30°	4	Sludge measurement port
1 @ 150°	4	Sludge measurement port
1 @ 270°	4	Sludge measurement port
2	4	Liquid level, level-indicating transmitter

Table 2-2. Tank 241-AP-108 Risers.[1,2,3] (2 sheets)

Riser Number[4]	Diameter (Inches)	Description and Comments
3	12	Supernatant pump, central pump pit (pit)
4	12	Thermocouple tree
5 @ 90°	42	Manhole; riser plug
5 @ 180°	42	Manhole; riser plug
7 @ 255°	12	Spare; riser plug
7 @ 300°	12	Primary tank exhaust
10 @ 210	12	Spare; riser plug
10 @ 330°	12	Spare; riser plug
11	42	Slurry distributor, central pump pit (pit)
12	12	Observation port, spare
13	12	Tank pressure
14	4	Supernatant return
15	4	Spare; riser plug
16 @ 30°	12	Sludge measurement port
16 @ 150°	12	Sludge measurement port
16 @ 330°	12	Sludge measurement port
21	4	Spare; riser plug
22	4	Sludge measurement port
24	4	Spare; riser plug
25	4	High liquid level sensor
26	4	Liquid level indicator
27 @ 225°	4	Spare; riser plug
27 @ 270°	4	Spare; riser plug
27 @ 330°	4	Spare; riser plug
28	4	Spare; riser plug

Notes:

[1]Salazar (1994)
[2]WHC (1994)
[3]WHC (1985)
[4]Indicates degrees clockwise from North for risers without unique identification numbers.

Figure 2-1. Riser Configuration for Tank 241-AP-108.

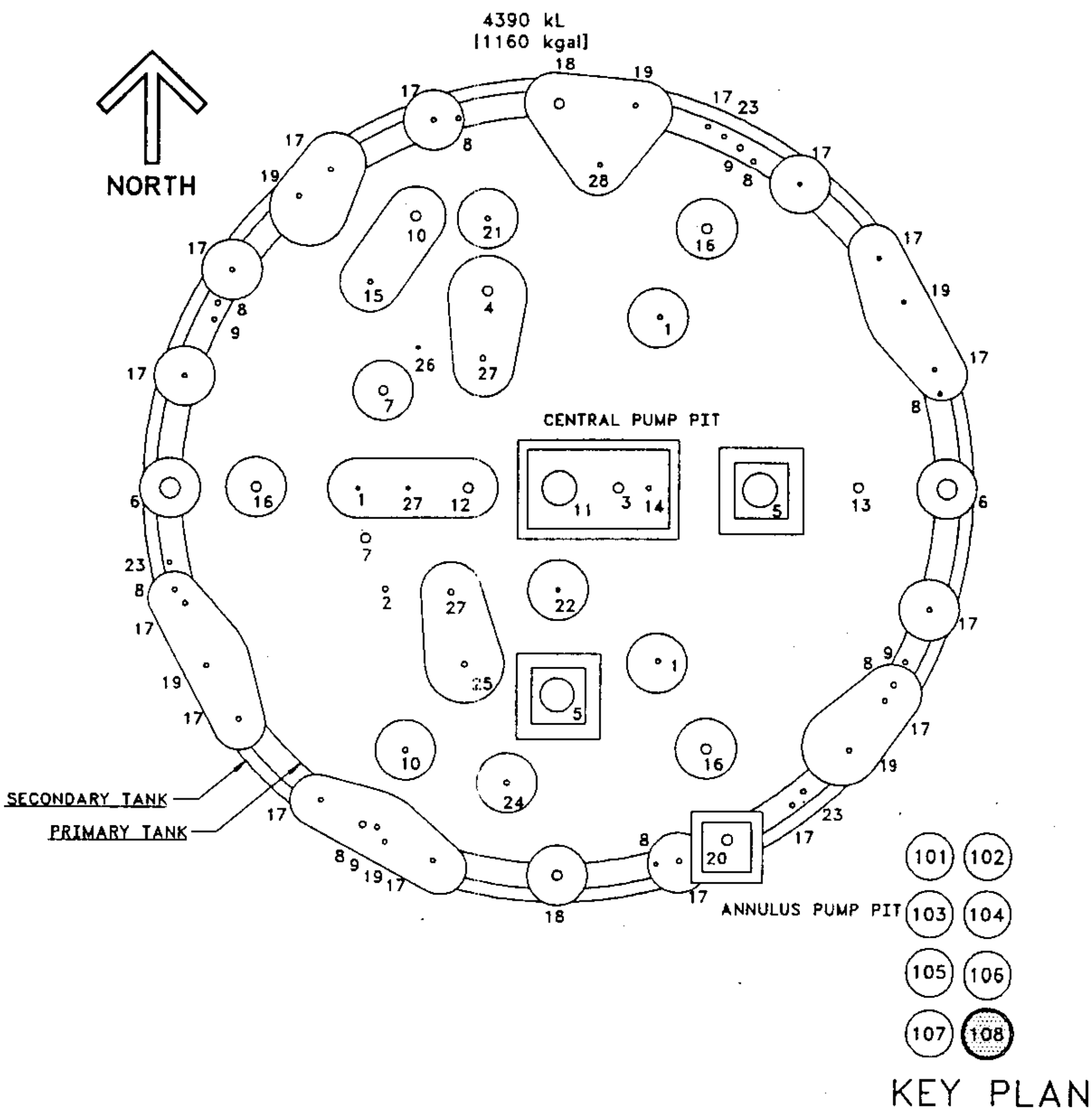
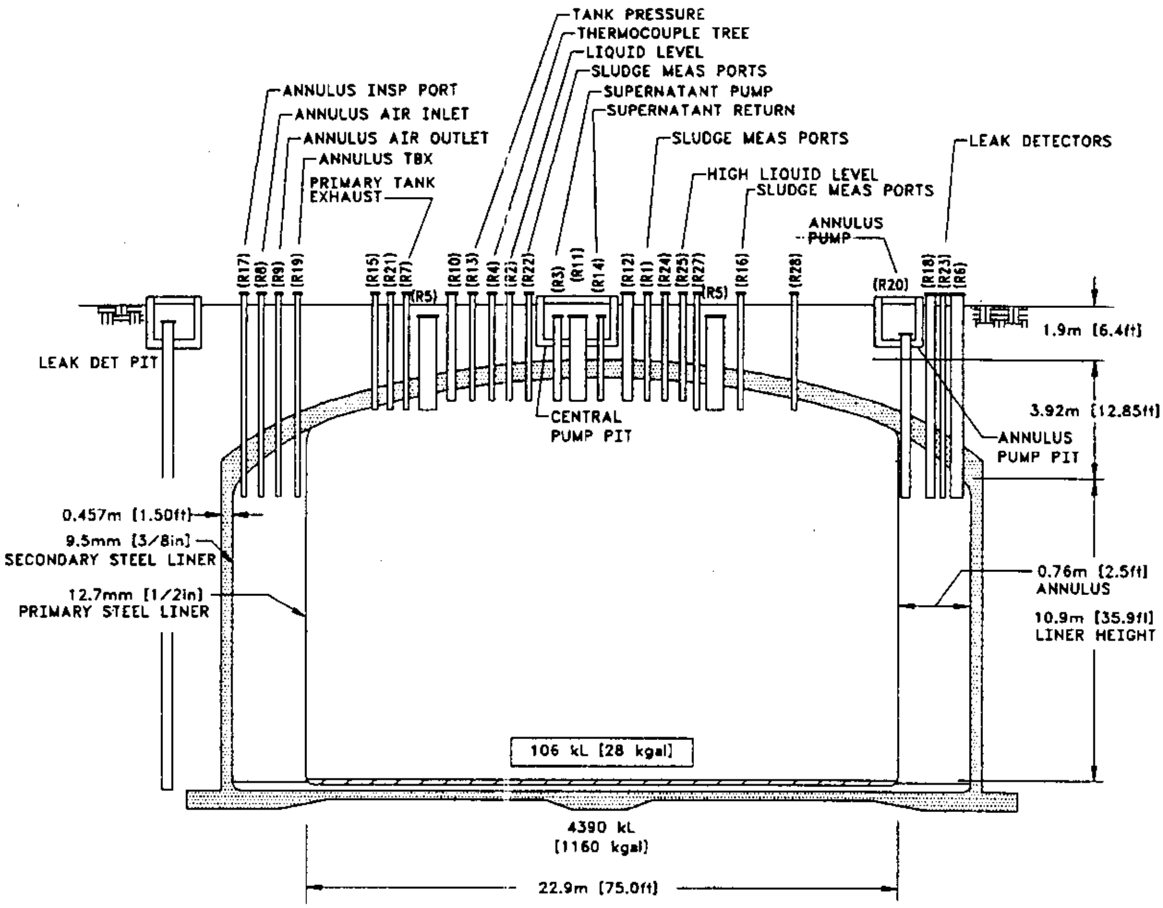


Figure 2-2. Tank 241-AP-108 Cross Section.



2.3 PROCESS KNOWLEDGE

The following sections present the history of waste transfers for tank 241-AP-108. The major waste transfers into tank 241-AP-108 are presented in Section 2.3.1 and Tables 2-3 and 2-4. Table 2-3 contains the major waste transfers until January 1, 1994. Table 2-4 and Section 2.3.1.1 are from a database developed for waste volume projections and have not been validated. The table lists waste transfers occurring after January 1, 1994. Section 2.3.2 describes the estimation of the tank's waste contents.

2.3.1 Waste Transfer History

Tank 241-AP-108 first received water in the third quarter of 1986 to test the integrity of the completed tank before waste was received. The first waste stream to enter tank 241-AP-108 was PUREX ammonia scrubber feed waste during the first quarter of 1990. The waste is derived from the scrubber for the cladding dissolver off-gas.

From the first quarter of 1991 until the second quarter of 1992, tank 241-AP-108 received nine separate transfers of dilute non-complexed waste from miscellaneous PUREX waste streams. The total amount of waste transferred into tank 241-AP-108 during this period was 348 kL (92 kgal), with the largest noted transfer being 87 kL (23 kgal).

A waste transfer from tank 241-AY-102 into tank 241-AP-108 occurred during the fourth quarter of 1991. The activity of tank 241-AY-102 makes determining the waste type of this transfer difficult. It appears the waste was primarily B Plant low-level waste that was pumped from single-shell tanks along with smaller quantities of decontamination waste from an unknown origin.

Several transfers occurred after January 1, 1994, and are noted in Table 2-4. These transfers significantly changed the waste compared to the waste in the tank as of the historical end date of January 1, 1994. As of the historical end date, the tank contained 3,403 kL (899 kgal) of waste. As of January 1996, the tank contained only 106 kL (28 kgal) of dilute, non-complexed supernatant waste.

Table 2-3. Summary of Tank 241-AP-108 Waste Input History.[1,2]

Transfer Source	Waste Type Received	Time Period	Estimated Waste Volume	
			kL	kgal
A-Plant (PUREX)	PUREX ammonia scrubber feed	1990	420	110
A-Plant (PUREX)	PUREX dilute non-complexed	1991 - 1992	350	92
241-AY-102	B-Plant low level and decontamination	1991	2,590	685
Unknown waste addition	Dilute non-complexed	1992 - 1993	15	4

Notes:

[1]Agnew et al.(1996b)

[2]Waste volumes and types are best estimates based on historical data.

Table 2-4. Summary of Tank 241-AP-108 Waste Transfers after January 1, 1994. (2 sheets)

Type of Entry	From	To	Start Date	End Date	Estimated Volume	
					kL	kgal
LO	AP-108	Unknown	1/1/94	1/31/94	-4	-1
TR	AY-102	AP-108	2/28/94	1/31/94	890	235
LO	AP-108	Unknown	2/28/94	2/28/94	-8	-2
TR	AP-108	AP-101	10/7/94	10/7/94	-1,075	-284
TR	AP-108	AW-102	10/15/94	10/15/94	-3,096	-818
TR	AW-105	AP-108	11/25/94	11/30/94	1,820	480
TR	AW-105	AP-108	12/1/94	12/3/94	1,075	284
TR	AP-108	AP-101	1/20/95	1/21/95	-2,896	-765
LO	AP-108	Unknown	4/1/95	4/30/95	-4	-1
TR	AP-106	AP-108	5/4/95	5/6/95	3,536	934

Table 2-4. Summary of Tank 241-AP-108 Waste Transfers after January 1, 1994. (2 sheets)

Type of Entry	From	To	Start Date	End Date	Estimated Volume	
					kL	kgal
TR	AP-108	AW-102	5/23/95	5/25/95	-1,408	-372
LO	AP-108	Unknown	6/1/95	6/30/95	-4	-1
TR	AP-108	AW-102	6/13/95	6/21/95	-2,116	-559
GA	Unknown	AP-108	7/1/95	7/31/95	4	1
LO	AP-108	Unknown	8/1/95	8/31/95	-4	-1
LO	AP-108	Unknown	9/1/95	9/30/95	-4	-1

Notes:

GA - gain of volume
LO - loss of volume
TR - transfer

[1]The data contained in this table have not been validated.

2.3.2 Historical Estimation of Tank Contents

The following is an estimate of the contents for tank 241-AP-108 as of January 1, 1994, based on the historical end date. These data are presented for information only. Due to the transfers after this date, these data cannot be compared to the latest sampling event (January 1996). The historical data used for the estimate are from: *Waste Status and Transaction Record Summary* (WSTRS) *for the Southeast Quadrant* (Agnew et al. 1996a); *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3* (Agnew et al. 1996b), which contains the Hanford Defined Waste (HDW) list and the Tank Layer Model (TLM); and *Historical Tank Content Estimate for the Southwest Quadrant of the 200 West Area* (HTCE) (Brevick et al. 1995a). WSTRS is a compilation of available waste transfer and volume status data. The HDW provides the assumed typical compositions for Hanford Site waste types. In most cases the available data are incomplete, reducing the reliability of the transfer data and the derived modeling results. The TLM uses the WSTRS data to model the waste deposition processes and, using additional data from the HDW (which may introduce more error), generates an estimate of the tank contents. Thus, these model predictions can only be considered an estimate that requires further evaluation using analytical data. Table 2-5 shows an estimate of the expected waste constituents and concentrations as of January 1, 1994.

Table 2-5. Tank 241-AP-108 Historical Inventory Estimate for Tank 241-AP-108 on January 1, 1994.[1,2] (2 sheets)

Total Inventory Estimate			
Physical Properties			
Total solid waste	4.59E+06 kg (1,130 kgal)		
Heat load	1.21 kW (4.14E+03 Btu/hr)		
Bulk density	1.07 (g/cc)		
Water wt%	88.3		
Total organic carbon wt% carbon (wet)	0.228		
Chemical Constituents	**mole/L**	**ppm**	**kg**
Na^{+}	1.53	3.29E+04	1.51E+05
Al^{3+}	0.219	5.51E+03	2.53E+04
Fe^{3+} (total Fe)	1.39E-03	72.4	332
Cr^{3+}	1.45E-03	70.4	323
Bi^{3+}	1.57E-06	0.306	1.40
La^{3+}	3.36E-08	4.35E-03	2.00E-02
Hg^{2+}	2.81E-08	5.26E-03	2.41E-02
Zr (as $ZrO(OH)_2$	5.72E-06	0.487	2.23
Pb^{2+}	5.25E-06	1.01	4.66
Ni^{2+}	1.04E-03	57.2	262
Sr^{2+}	1.12E-08	9.15E-04	4.20E-03
Mn^{4+}	5.15E-04	26.4	121
Ca^{2+}	6.25E-03	234	1.07E+03
K^{+}	6.82E-03	249	1.14E+03
OH^{-}	0.983	1.56E+04	7.15E+04
NO_3^{-}	0.729	4.22E+04	1.94E+05
NO_2^{-}	5.03E-02	2.16E+03	9.91E+03
CO_3^{2-}	0.121	6.75E+03	3.10E+04
PO_4^{3-}	1.01E-02	893	4.10E+03
SO_4^{2-}	2.06E-02	1.85E+03	8.48E+03

Table 2-5. Tank 241-AP-108 Historical Inventory Estimate for Tank 241-AP-108 on January 1, 1994.[1,2] (2 sheets)

Chemical Constituents (Cont'd)	mole/L	ppm	kg
Si (as SiO_3^{2-})	1.43E-02	374	1.72E+03
F^-	8.64E-04	15.3	70.3
Cl^-	2.75E-02	910	4.17E+03
$C_6H_5O_7^{3-}$	6.12E-03	1.08E+03	4.95E+03
$EDTA^{4-}$	3.51E-05	9.43	43.3
$HEDTA^{3-}$	6.28E-05	16.1	73.7
glycolate$^-$	8.12E-02	5.68E+03	2.61E+04
acetate$^-$	2.36E-05	1.30	5.96
oxalate^{2-}	2.87E-08	2.36E-03	1.08E-02
DBP	3.19E-04	47.9	220
butanol	3.19E-04	22.1	101
NH_3	6.60E-03	105	480
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents			
Pu		1.24E-02 (μCi/g)	0.946 (kg)
U	1.73E-03 (M)	383 (μg/g)	1.76E+03 (kg)
Cs	3.67E-02 (Ci/L)	34.2 (μCi/g)	1.57E+05 (Ci)
Sr	1.65E-02 (Ci/L)	15.4 (μCi/g)	7.07E+04 (Ci)

Notes:

[1]These estimates have not been validated and should be used with caution. These estimates are only relevant to January 1, 1994 and are not relevant to the tank contents as of January 1996.

[2]Agnew et al. (1996a)

The tank layer model does not take into account tanks transfers subsequent to January 1, 1994. Because tank 241-AP-108 had many tank transfers after January 1, 1994, this historical model information is provided for completeness and is not relevant to the current tank contents.

As of January 1996, tank 241-AP-108 contained only 106 kL (28 kgal) of supernatant waste. The contents of the tank were noted as being dilute non-complexed waste, though the exact generating source is unknown. As of June 1996, tank 241-AP-108 had received two transfers of dilute complex waste from B Plant totaling 72 kL (19 kgal).

Since the addition of B Plant complex waste, tank 241-AP-108 has been designated as a complex receiver tank that as of June 1996 held 178 kL (47 kgal) of dilute complex waste.

2.4 SURVEILLANCE DATA

Tank 241-AP-108 surveillance consists of surface level measurements (liquid and solid), temperature monitoring inside the tank (waste and headspace), and leak detection well monitoring for radioactive liquids outside the primary tank. Liquid level measurements indicate major leaks into or out of the tank. Solid surface level measurements provide an indication of the physical changes and consistency of the solid layers of a tank. Leak detection systems within the annulus of the tank will detect leaks from the primary tank. These data provide the basis for determining tank integrity.

2.4.1 Surface Level Readings

Waste surface level monitoring is being performed with a Food Instrument Corporation (FIC) gauge and a manual tape. Because this is an active tank, the surface level is continually subject to change. The measured waste surface level on June 19, 1996 was 0.431 m (17 in.), which equals approximately 178 kL (47.0 kgal). A graphical representation of the volume measurements is presented as a level history graph in Figure 2-3.

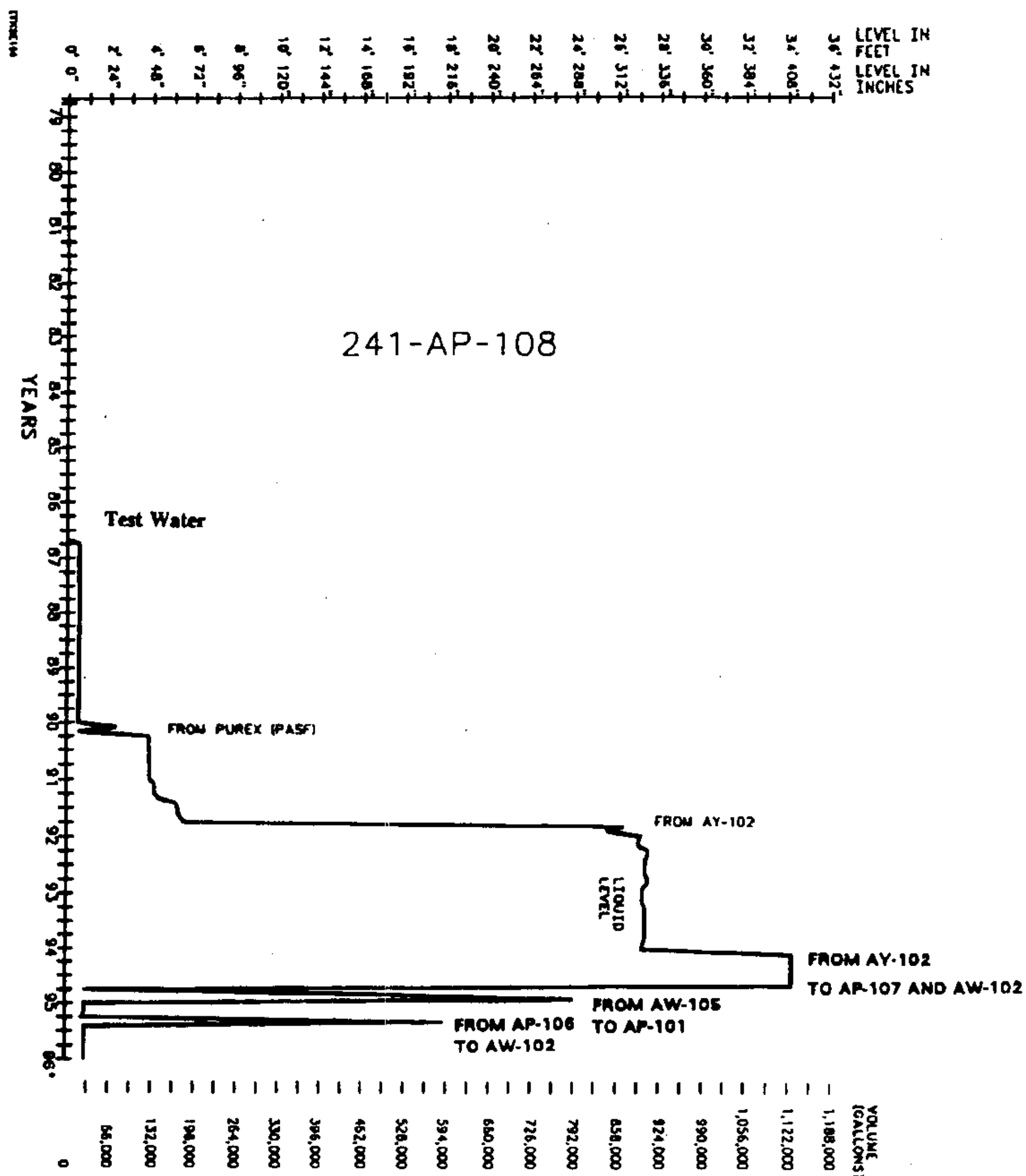
2.4.2 Internal Tank Temperatures

Temperature data for tank 241-AP-108 are recorded by 18 thermocouples on one thermocouple tree located in riser 4. Temperature data from the Computer Automated Surveillance System (CASS) recorded from April 1986 to March 1995 are available for all 18 thermocouples. Temperature data from the Surveillance Analysis Computer System (SACS) recorded from July 1989 to June 1995 are available for twelve of the thermocouples. There are several small breaks in the temperature data. The average temperature of all SACS data from July 1989 to April 1996 was 21 °C (70 °F), the minimum temperature was 6.1 °C (43 °F), and the maximum temperature was 41.7 °C (107 °F). Over the last year the average temperature was 22 °C (72 °F), the minimum temperature was 10 °C (50 °F), and the maximum temperature was 38 °C (101 °F). The minimum temperature on April 29, 1996 was 15 °C (59 °F) on thermocouple 5 and the maximum was 16 °C (61 °F) on thermocouple 11. Both thermocouples were in the vapor space at the time of the reading. A graph of the weekly high temperatures can be found in Figure 2-4. Plots of the individual thermocouple readings for tank 241-AP-108 can be found in the supporting document for the HTCE (Brevick et al. 1995b).

2.4.3 Tank 241-AP-108 Photographs

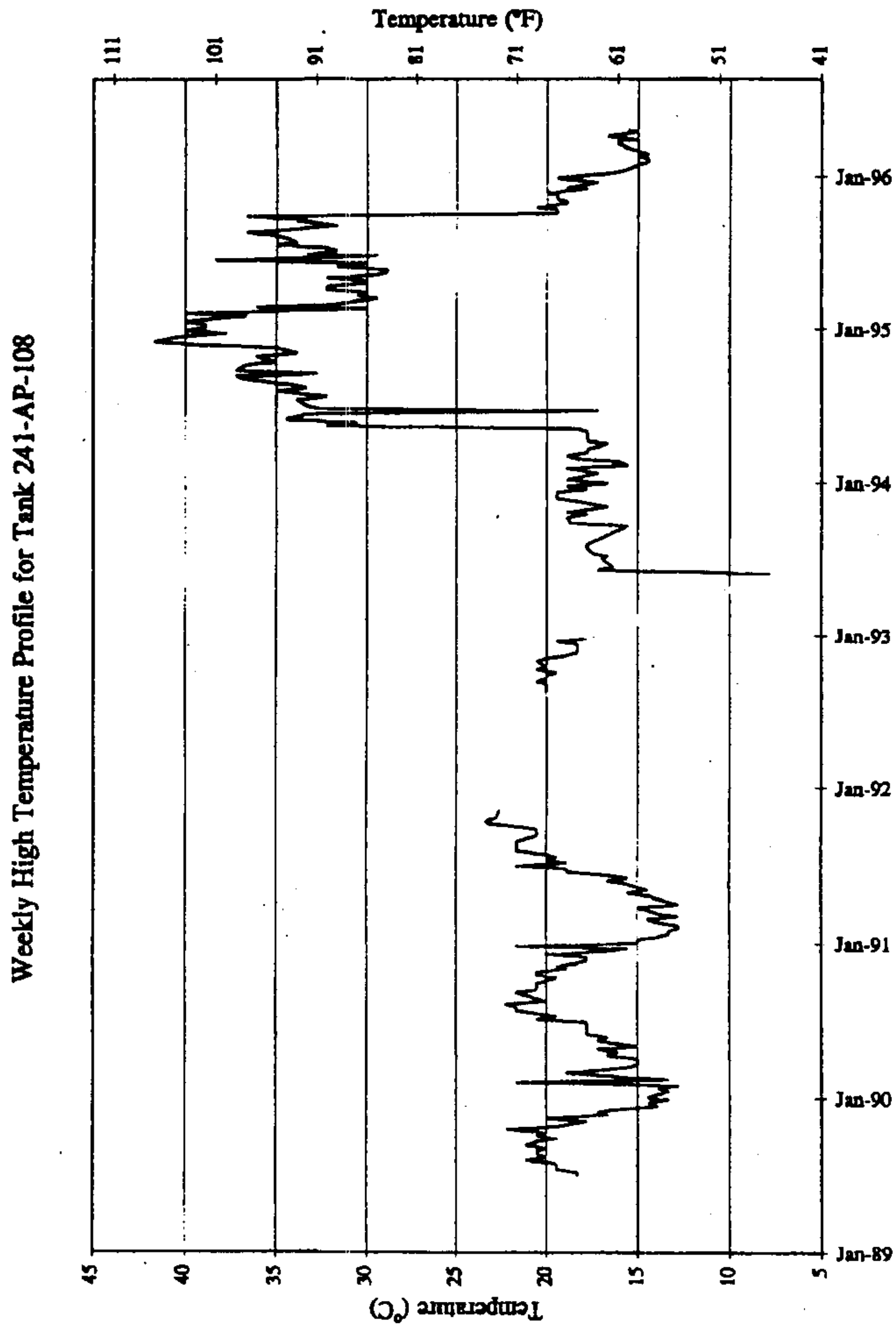
No interior photographs are available.

Figure 2-3. Tank 241-AP-108 Level History.



*Dilute complex waste from B Plant was added to tank 241-AP-108 in April and June of 1996 to increase the total waste volume to 178 kL (47 kgal).

Figure 2-4. Tank 241-AP-108 Weekly High Temperature Plot.



3.0 TANK SAMPLING OVERVIEW

This section describes the January 1996 grab sampling and analysis event for tank 241-AP-108. Two grab samples were obtained to satisfy the requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995). The sampling and analyses were performed in accordance with the *Tank 241-AP-108 Grab Sampling and Analysis Plan* (Baldwin 1996). Further discussions of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

3.1 DESCRIPTION OF SAMPLING EVENTS

Tank 241-AP-108 was grab sampled on January 4, 1996. Sample 8AP-96-1 was acquired from riser 1 at 30° and sample 8AP-96-2 from riser 1 at 150°. A field blank, sample number 8AP-96-FB, was also taken from riser 1 at 30°. All samples were received by the Westinghouse Hanford Company 222-S Laboratory on the day the samples were obtained.

The bottle-on-a-string sampling method was used to obtain the grab samples. The tank headspace was sampled from the two risers through which grab samples were obtained, and analyzed for flammable gas as prescribed by the safety screening DQO. Analytical results of the safety screening analyses showed good agreement between the two risers. Therefore, additional samples were not necessary. Table 3-1 summarizes the sampling mode, applicable DQOs, and sampling and analytical requirements for the sampling events.

Table 3-1. Integrated Data Quality Objective Requirements for Tank 241-AP-108.[1]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
January 1996 grab sampling	Safety screening (Dukelow et al. 1995)	Vertical profiles from two widely spaced risers showed good agreement. Additional samples were not necessary.	▸ Fuel energy value ▸ Fissiles or total alpha ▸ Concentration of flammable gas
	Waste compatibility (Fowler 1995)	Grab samples from same depths	▸ Energetics ▸ Moisture content ▸ Metals by ICP ▸ Anions by IC ▸ Radionuclides ▸ Total carbon ▸ Hydroxide ▸ Density ▸ pH ▸ Percent solids ▸ Visual check for presence of organic layer

Note:

[1]Baldwin (1996)

3.2 SAMPLE HANDLING

The grab samples were shipped to the 222-S Laboratory for subsampling and analysis. Samples 8AP-96-1, 8AP-96-2, and 8AP-96-FB were assigned LABCORE numbers S96T000088, S96T000096, and S96T000089 (field blank), respectively. The sampling bottles were 125 mL in size, and full recovery was obtained from all three. The samples were visually inspected for color, clarity, and solids content, and over-the-top radiation measurements were taken. All samples were a clear, yellow liquid (with the exception of the field blank, which was colorless) with no visible solids and no organic layer. The samples were then subsampled into portions of approximately 20 mL (40 mL for the field blank subsample) for the different analyses and for archiving. A description of the samples is presented in Table 3-2.

Table 3-2. Grab Sample Descriptions.[1]

Riser	Customer ID	Laboratory ID (Labcore Number)	Sample Elevation[2]	Sample Volume	Over-the-Top Radiation
			m (in.)	mL	mrad/hr
1 @ 30°	8AP-96-1	S96T000088	16.38 (645)	125	110
	8AP-96-FB	S96T000089	6.09 (240)	125	< 0.5
1 @ 150°	8AP-96-2	S96T000096	16.38 (645)	125	110

Notes:

ID = identification

[1]Esch (1996)

[2]Sample elevation is the distance from the top of the riser to the mouth of the sample bottle. Note that the sample elevation of the field blank is above the waste surface.

3.3 SAMPLE ANALYSIS

Samples 8AP-96-1, 8AP-96-2, and 8AP-96-FB were analyzed for both safety screening evaluation and waste compatibility assessment. Common analytes required for both evaluations include: energetics (by DSC) to ascertain the fuel energy value, weight percent water (by TGA) to obtain total moisture content, and density. Total alpha activity for determining the criticality potential is an additional analyte required for the safety screening evaluation.

Analysis of the tank headspace gases for flammability was also required by the safety screening DQO. A combustible gas meter was used for the analysis. Additional analytes required for the waste compatibility assessment (Baldwin 1996) included: metals by ICP, anions by IC, OH^-, TIC, TOC, ^{241}Am, $^{239/240}Pu$, ^{137}Cs, $^{89/90}Sr$, pH, specific gravity, percent solids, and a visual check for the presence of an organic layer. The purpose of the Waste Transfer Compatibility Program is to establish specifications for waste transfers into and within the DST system to prevent safety or operational problems such as flammable gas accumulation, tank corrosion and transfer line plugging. Sampling and analytical requirements from the applicable DQOs were summarized in Table 3-1.

The volume percent solids by centrifugation test was not performed due to the absence of solids in the supernatant samples.

The duplicate analysis for TIC and TOC was inadvertently omitted from the runs for grab sample 8AP-96-2 (S96T000097). The sample was not rerun for the following reasons: 1) the sample results were consistent with those for sample 8AP-96-1 (S96T000090); 2) the samples were analyzed in the same batch with 8AP-96-1, which had very good precision for these two analytes, and for liquid samples, it was believed that the precision for sample 8AP-96-2 may be similar; and 3) the TOC sample result was two orders of magnitude below the decision criteria threshold of 30,000 μg C/mL (Esch 1996).

Quality control (QC) checks include, where appropriate, laboratory control standards, matrix spikes, duplicate analyses, and blanks. Results of the QC tests and the implications for data quality are discussed in Section 5.1.2.

All reported analyses were performed in accordance with approved laboratory procedures. A list of the analyses performed on specific samples is presented in Table 3-3. Table 3-4 summarizes the instruments, preparation methods, and analytical procedure numbers used in the analysis of the tank 241-AP-108 samples.

Table 3-3. Tank 241-AP-108 Sample Analysis Summary.[1]

Customer ID	Laboratory ID (Labcore Number)	Subsample Labcore Number	Analysis
8AP-96-1	S96T000088	S96T000090	DSC, TGA, TOC, TIC, ICP (Al, Fe, Na), IC (anions), pH, OH^-, Specific gravity
		S96T000092	GEA (^{137}Cs), $^{239/240}$Pu, $^{89/90}$Sr, ^{241}Am, Total alpha activity
		S96T000094	Archive
8AP-96-2	S96T000096	S96T000097	DSC, TGA, TOC, TIC, ICP (Al, Fe, Na), IC (anions), pH, OH^-, Specific gravity
		S96T000098	GEA (^{137}Cs), $^{239/240}$Pu, $^{89/90}$Sr, ^{241}Am, Total alpha activity
		S96T000099	Archive
8AP-96-FB (Field blank)	S96T000089	S96T000091	DSC, TGA, TOC, TIC, ICP (Al, Fe, Na), IC (anions), pH, OH, Specific gravity
		S96T000093	GEA (^{137}Cs), $^{239/240}$Pu, $^{89/90}$Sr, ^{241}Am, Total alpha activity
Vapor tests of tank headspace	N/A	N/A	Combustible gas meter readings for: flammable gas, oxygen, ammonia, and TOC concentration

Note:
[1]Esch (1996)

Table 3-4. Analytical Procedures.[1]

Analyte	Instrument	Preparation Procedure	Procedure Number[2]
Energetics by DSC	Differential scanning calorimetry	All analyses were performed directly on the liquid samples.	LA-514-114, Rev. C-1
Percent water by TGA	Thermogravimetric analyses		LA-514-114, Rev. C-1
Total alpha activity	Alpha proportional counter		LA-508-101, Rev. D-2
Specific gravity	Not applicable		LA-510-112, Rev. C-3
Total metals	Inductively coupled plasma/ atomic emission spectrometer		LA-505-151, Rev. D-3
Anions	Ion chromatograph		LA-533-105, Rev.D-1
^{137}Cs, ^{134}Cs, ^{60}Co	Gamma energy analysis		LA-548-121, Rev. D-1
$^{89/90}Sr$	Separation and counting		LA-220-101, Rev. D-1
OH^-	Potentiometric titration		LA-211-102, Rev. C-0
H^+	pH electrode		LA-212-106, Rev. A-0
TOC	Furnace oxidation		LA-344-105, Rev. C-0
TIC	Furnace oxidation		LA-622-102, Rev. C-0
$^{239/240}Pu$	Separation and counting		LA-943-127, Rev. B-1
^{241}Am	Separation and counting		LA-953-103, Rev. A-4
Flammable gas	Combustible gas meter	N/A	WHC-IP-0030, IH 1.4 and IH 2.1

Notes:

N/A = not applicable
Rev. = revision

[1]Esch (1996)

[2]All procedures are from Westinghouse Hanford Company, Richland, Washington.

3.4 HISTORICAL SAMPLING EVENT

Prior to the most recent sampling, tank 241-AP-108 was last sampled in March 1994. Since that time, there have been several waste transfers into and out of the tank associated with staging waste for processing through the 242-A Evaporator. As expected, the results from the historical sampling event are not representative of the current tank contents. As mentioned in Section 2.3.1, the tank probably contained primarily B Plant low-level and decontamination waste. Results from the March 1994 sampling event have been included in this characterization report for informational purposes only.

On March 17, 18, and 21, 1994, five 100 mL supernate samples were retrieved from tank 241-AP-108 using the bottle-on-a-string sampling method (Miller 1994). The samples were collected at two different depths from riser 1 at 30° [2.4 m (96 in.) and 5.79 m (228 in.) from the tank bottom] and riser 1 at 270° [3.35 m (132 in.) and 5.18 m (204 in.) from the tank bottom], and at one depth from riser 1 at 150° [4.57 m (180 in.) from the tank bottom]. Visually, the samples were described as homogeneous. The laboratory data from this sampling event are included in Appendix B.

4.0 ANALYTICAL RESULTS

Section 4 presents a summary of the analytical results associated with the January 1996 sampling of tank 241-AP-108. The sampling and analysis parameters governing this event were integrated by and described in the sampling and analysis plan (SAP) (Baldwin 1996). Analysis of the grab samples was performed at the Westinghouse Hanford Company 222-S Laboratory.

Data locations for this characterization report are displayed in Table 4-1. As noted in Table 4-1, the complete analytical data set can be found in Appendix A. Only analyte overall means are reported in Section 4.

Table 4-1. Analytical Data Presentation Tables.

Data Type	Tabulated Location
Chemical data summary	Table 4-2
Headspace flammability screening results	Table 4-3
Comprehensive analytical data	Appendix A

4.1 DATA PRESENTATION

This section summarizes the analytical results from the January 1996 sampling of tank 241-AP-108. The data were reported in the *Revised Final Report for Tank 241-AP-108, Grab Samples 8AP-96-1, 8AP-96-2 and 8AP-96-FB* (Esch 1996). Section 4.1.1 presents the chemical data, Section 4.1.2 contains the physical data, and Section 4.1.3 presents the headspace flammability results.

4.1.1 Chemical Data Summary

Data from the two grab samples were combined to derive an overall mean for all analytes with the exception of DSC, which does not require the calculation of a mean. The overall mean was calculated by first averaging the primary and duplicate results for each grab sample. These sample means were then averaged to derive the overall mean. When all measurements had detected results, the overall mean was reported as a detected value. Conversely, when all measurements had nondetected results, the overall mean was reported as a nondetected value. Because means and projected inventories reported as nondetected ("<") are biased high, these estimates should be used with caution.

All information contained in Table 4-2 was taken from the Appendix A tables. The first two columns of Table 4-2 contain the analyte and overall mean. The third column displays the relative standard deviation (RSD) of the mean, defined as the standard deviation (of the mean) divided by the mean, multiplied by 100. The RSDs were determined by using standard analysis of variance (ANOVA) statistical techniques (nested model), and were computed only for those analytes that had all of the measurements above the detection limit. The projected inventories listed in the final column were derived by multiplying the overall mean in μg/mL, μg C/mL, or μCi/mL by the waste volume of 106 kL (28 kgal) and using the appropriate conversion factors.

Table 4-2. Chemical Data Summary for Tank 241-AP-108.[1] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
METALS	**μg/mL**	**%**	**kg**
Aluminum	1,070	1.9	113
Iron	< 5.05	N/A	< 0.535
Sodium	17,400	3.6	1,840
ANIONS	**μg/mL**	**%**	**kg**
Chloride	190	10.5	20.1
Fluoride	575	4.7	61.0
Hydroxide	2,770	0.5	294
Nitrate	14,800	1.2	1,570
Nitrite	3,730	0.3	395
Phosphate	299	18.8	31.7
Sulfate	515	20.3	54.6
RADIONUCLIDES	**μCi/mL**	**%**	**Ci**
^{241}Am	< 2.18E-05	N/A	< 0.00231
^{137}Cs	19.5	0.8	2,070
^{60}Co	< 6.44E-04	N/A	< 0.0683
$^{239/240}Pu$	5.99E-05	0.4	0.00635
$^{89/90}Sr$	0.0311	9.4	3.30
Total alpha	< 7.15E-04	N/A	< 0.0758
CARBON	**μg C/mL**	**%**	**kg C**
Total inorganic carbon	1,730	0.4	183
Total organic carbon	398	0.2	42.2

Table 4-2. Chemical Data Summary for Tank 241-AP-108.[1] (2 sheets)

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
PHYSICAL PROPERTIES		%	kg
pH	13.2	1.1	---
Wt% water	93.0	0.3	1.01E+05
Specific gravity	1.02	0.2	---

Note:
[1]Esch (1996)

4.1.2 Physical Data Summary

Thermal analyses and density measurements were performed on the tank 241-AP-108 grab samples to satisfy the requirements of the safety screening DQO (Dukelow et al. 1995) and the waste compatibility DQO (Fowler 1995). In addition, pH measurements were performed on the samples.

4.1.2.1 Thermogravimetric Analysis. During a TGA, the mass of a sample is measured while its temperature is increased at a constant rate. Nitrogen is passed over the sample during the heating to remove any released gases. Any decrease in the weight of a sample represents a loss of gaseous matter from the sample either through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 °C [302 °F]) is due to water evaporation. Weight percent water by TGA was performed by the 222-S Laboratory on a Perkin-Elmer™ instrument using procedure LA-514-114, Rev. C-1.

The TGA results for tank 241-AP-108 are presented in Appendix A in Table A-20. All samples exhibited a large weight loss between the ambient temperature and 147 °C (297 °F). Again, this weight loss is attributed to the evaporation of water. The overall mean percent water for the tank is 93.0 wt%.

4.1.2.2 Differential Scanning Calorimetry. During a DSC analysis, heat absorbed or emitted by a substance is measured while the substance is exposed to a linear increase in temperature. While the substance is being heated, nitrogen is passed over the waste material to remove any gases being released. The onset temperature for an endothermic (characterized by or causing the absorption of heat) or an exothermic (characterized by or causing the release of heat) event is determined graphically. Analyses by DSC were performed by the 222-S Laboratory on a Perkin-Elmer™ instrument using procedure LA-514-114, Rev. C-1.

The DSC results are presented in Appendix A, Table A-21. All reactions were endothermic; thus, none of the samples exceeded the safety screening action limit of -480 J/g. Only one transition was observed in all of the runs. The transition represents the endothermic reaction associated with the evaporation of free and interstitial water. The peak temperature for the endothermic reaction and the magnitude of the enthalpy change are provided in Table A-21. These results are reported on a wet weight basis. Because no exothermic reactions occurred, the calculation of a 95 percent confidence interval as required by the safety screening DQO (Dukelow et al. 1995) was not necessary.

4.1.2.3 Specific Gravity. Specific gravity measurements were performed on the samples using procedure LA-510-112, Rev. C-3. The analysis was performed in duplicate and the results are presented in Table A-22. The overall tank specific gravity was 1.02.

4.1.2.4 pH Measurements. Measurements for pH were performed on the samples using procedure LA-212-106, Rev. A-0. The analysis was performed in duplicate and the results are presented in Table A-19. The overall tank pH was 13.2. The pH results should be considered estimates, because they exceeded the calibration range of the instrument and instrument performance degrades at high pH (Esch 1996).

4.1.3 Headspace Flammability Screening Results

As requested in the SAP (Baldwin 1996), the tank 241-AP-108 headspace was sampled and analyzed for the presence of flammable gases prior to grab sampling. The safety screening DQO notification limit for flammable gas concentration is 25 percent of the lower flammability limit (LFL) (Dukelow et al. 1995). The combustible gas meter used to sample the tank headspace reports results as a percentage of the lower explosive limit (LEL). Because the National Fire Protection Association defines the terms LFL and LEL identically, the two terms may be used interchangeably (NFPA 1995). The reported LFL of 0 percent was well below the safety screening threshold. In addition, the concentration of oxygen gas, ammonia gas, and total organic carbon vapor were determined. The results of the combustible gas meter monitoring are presented in Table 4-3.

Table 4-3. Headspace Flammability Screening for Tank 241-AP-108.[1,2]

Vapor Characteristic Measured	Results	
	Riser 1@30°	Riser 1@150°
Flammability vapor concentration as percent of the LFL	0 %	0 %
Volume percent oxygen gas	20.9 %	20.8 %
Concentration of ammonia gas	0 ppm	0 ppm
Concentration of total organic carbon vapor	0.0 ppm	0.0 ppm

Note:

[1]Esch (1996)

[2]Data were determined using a combustible gas meter.

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5.0 INTERPRETATION OF CHARACTERIZATION RESULTS

The purpose of this chapter is to discuss the overall quality and consistency of the current sampling results for tank 241-AP-108, and to assess and compare these results against historical information and program requirements.

5.1 ASSESSMENT OF SAMPLING AND ANALYTICAL RESULTS

This section evaluates sampling and analysis factors that may impact interpretation of the data. These factors are used to assess the overall quality and consistency of the data and to identify any limitations in the use of the data. Many of the usual consistency checks were not possible given the limited scope of the analyses.

5.1.1 Field Observations

The safety screening DQO (Dukelow et al. 1995) requirement that initially at least two widely spaced risers be sampled was fulfilled, allowing a horizontal comparison of the analytical results. The comparison of the analytical results showed good agreement; therefore, additional samples were not required. The two grab samples and the field blank achieved 100 percent recovery. No anomalies or factors that might limit the use of the data were noted.

5.1.2 Quality Control Assessment

The usual QC assessment includes an evaluation of the appropriate standard recoveries, matrix spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All the pertinent QC tests were conducted on the 1996 grab samples, allowing a full assessment regarding the accuracy and precision of the data. As indicated in the SAP, the specific criteria for all QC checks were governed by the *Hanford Analytical Services Quality Assurance Plan* (DOE 1995). Any quality control results outside these criteria are identified by superscripts in the Appendix A tables.

The standard and spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike recovery is above or below the given criterion then the analytical results may be biased high or low, respectively. All standard recoveries were within the defined criterion. The only matrix spike outside the criterion was for sodium. This was due to the sodium results exceeding the spike concentrations by more than a factor of four. Therefore, the spike results should not be used (Esch 1996). The precision (estimated by the relative percent difference (RPD), which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times one hundred) between all sample pairs for all analytes were within the limits with the exception of one sample/duplicate pair for $^{89/90}Sr$. This pair had an RPD of 31.2 percent. Finally, a number of analytes were detected in the field blank and method blank, but all of these results were below the sample detection limits (Esch 1996). Thus, blank contamination was not a problem in any of the samples.

In summary, essentially all of the QC results were within the boundaries specified in the SAP. The two discrepancies noted should not impact either the validity or the use of the data.

5.1.3 Data Consistency Checks

Comparisons of different analytical methods can help to assess the consistency and quality of the data. A close correlation strengthens the credibility of both results, whereas a poor correlation brings the reliability of the data into question. The quantity of data available made possible the comparison of total alpha to the sum of the individual emitters and the calculation of mass and charge balances.

5.1.3.1 Comparison of Results from Different Analytical Methods. A comparison was made between the total alpha activity mean and the sum of the means of the individual alpha emitters (Table 5-1). The sum of the activities of the individual alpha emitters was determined by adding ^{241}Am and $^{239/240}Pu$ activities.

The gross alpha result indicates that the total of the alpha emitters should be less than 7.15E-04 μCi/mL, and this is borne out by the individual emitter results. The fact that the analytical estimates of ^{241}Am and total alpha activity were below the detection limit precludes any quantitative comparison.

Table 5-1. Tank 241-AP-108 Comparison of Gross Alpha Activities With the Total of the Individual Activities.

Analyte	Overall Mean (μCi/mL)
^{241}Am	< 2.18E-05
$^{239/240}Pu$	5.99E-05
Sum of alpha emitters	< 8.17E-05
Gross Alpha Activity	< 7.15E-04

5.1.3.2 Mass and Charge Balances. The principle objective in performing mass and charge balances is to determine if the measurements were self-consistent. In calculating the balances, only analytes listed in Table 4-2 that were detected at a concentration of 1,000 μg/g (0.1 wt%) or greater were considered. All analytical results presented in this section were first converted from μg/mL to μg/g (using the specific gravity mean of 1.02 g/mL) before use in the tables.

Sodium was the only cationic species detected in large quantities in the tank 241-AP-108 waste. However, only three metals were analyzed, which could create a low bias in the overall mass balance if an unmeasured metal were present in large quantities. Aluminum was assumed to be present as the aluminate anion, because the entire tank contents was supernatant. The carbonate data were derived from the TIC analyses. The other anionic analytes listed in Table 5-3 were assumed to be present as sodium salts and expected to balance the positive charge exhibited by sodium. The concentration of sodium in Table 5-2, the sum of the anionic species in Table 5-3, and the percent water estimate were then used to calculate the mass balance. The uncertainty estimates (RSDs) associated with each analyte are also given in the tables. The uncertainty estimates for the cation and anion totals, as well as the overall uncertainty given in Table 5-4, were computed by a statistical technique known as the propagation of errors (Nuclear Regulatory Commission 1988).

Table 5-2. Cation Mass and Charge Data.

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	RSD (Mean) (%)	Charge (μeq/g)
Sodium	17,100	Na^+	17,100	3.6	743
Total			17,100	3.6	743

Table 5-3. Anion Mass and Charge Data.

Analyte	Concentration (μg/g)	Assumed Species	Concentration of Assumed Species (μg/g)	RSD (Mean) (%)	Charge (μeq/g)
Aluminum	1,050	Ado_2^-	2,290	1.9	38.8
TIC	1,700	CO_3^{2-}	8,500	0.4	283
Hydroxide	2,720	OH^-	2,720	0.5	160
Nitrate	14,500	NO_3^-	14,500	1.2	234
Nitrite	3,660	NO_2^-	3,660	0.3	79.6
Total			31,700	0.6	795

Table 5-4. Mass Balance Totals.

Totals	Concentrations (µg/g)	RSD (Mean) %
Cation Total from Table 5-4	17,100	3.6
Anion Total from Table 5-5	31,700	0.6
Water	930,000	0.3
Grand Total	979,000	0.3

The mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from µg/g to weight percent.

Mass balance = Percent Water + 0.0001 x [Total Analyte Concentration]
= Percent Water + 0.0001 x [Na^+ + AlO_2^- + CO_3^{-2} + OH^- + NO_3^- + NO_2^-].

The total analyte concentration calculated from the above equation is 48,800 µg/g. The mean weight percent water obtained from thermogravimetric analysis reported in Table 4-2 is 93.0 percent. The mass balance resulting from adding the percent water to the total analyte concentration is 97.9 percent (Table 5-4).

The following equations demonstrate the derivation of total cations and total anions, and the charge balance is the ratio of these two values.

<u>Total cations</u> (µeq/g) = [Na^+]/23.0 = 743 µeq/g.

<u>Total anions</u> (µeq/g) = [AlO_2^-]/59.0 + [CO_3^{-2}]/30.0 + [OH^-]/17.0 + [NO_3^-]/62.0 + [NO_2^-]/46.0 = 795 µeq/g.

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 0.935.

In summary, the above calculations yield reasonable (close to 1.00 for charge balance and 100 percent for mass balance) mass and charge balance values, indicating that the analytical results are generally self-consistent.

5.1.3.3 Thermogravimetric Analysis/Differential Scanning Calorimetry Comparison. The energy required to convert water to steam is 2,260 J/g. The TGA results for 241-AP-108 give an overall mean of 93 percent water (Table A-20). Ninety-three percent of 2,260 J/g is 2,101 J/g, which agrees with the DSC results for tank 241-AP-108 (Table A-21).

5.2 COMPARISON OF HISTORICAL WITH ANALYTICAL RESULTS

Prior to the January 1996 sampling event, the most recent sampling of tank 241-AP-108 occurred in March 1994. Due to multiple waste transfers since this last sampling event, no valid comparison between any of the 1996 results and the 1994 samples was possible. The 1994 results are reported in Appendix B for informational purposes only.

5.2.1 Comparison of Analytical Results with Analytical Results from Tank 241-AP-106

Material from tank 241-AP-106 was the last transfer to tank 241-P-108 prior to the January 1996 sample event. Before the transfer of tank 241-AP-106 material, tank 241-AP-108 was pumped almost empty. Therefore, the tank 241-AP-108 analytical results should agree with the results of the tank 241-AP-106 analytical results (Simpson et al. 1994) prior to the transfer to tank 241-AP-108. Table 5-6 provides a comparison of tanks 241-AP-108 and 241-AP-106 analytical results. The comparison shows a generally consistent factor of 3 to 5 higher analyte concentrations for tank 241-AP-108 compared to those of 241-AP-106. This concentration may be a result of settling and evaporation.

5.3 TANK WASTE PROFILE

According to the estimate of Hanlon (1996), the approximately 25 to 28 cm (10 to 11 in.) of waste in tank 241-AP-108 was expected to consist entirely of 106 kL (28 kgal) of supernatant. Both samples were described as clear and yellow. Based on this evidence, the tank contents were expected to be homogeneous.

The fact that two different risers were sampled allowed a statistical procedure known as the ANOVA (Nested Model) to be conducted on the 1996 grab samples in order to determine whether there were horizontal variability in the analyte concentrations. These calculations were performed only for analytes that had all of their individual measurements above the detection limit. Of the 17 analytes that met this qualification, the ANOVA was conducted on 15 of them. Statistics could not be conducted on aluminum and specific gravity due to peculiarities in the data sets that precluded analysis. For aluminum, each sample pair had primary and duplicate runs that were identical, eliminating the analytical error term from the ANOVA calculation. For specific gravity, a similar difficulty arose, but in this case the two sample pairs produced identical means, eliminating the between-riser error term from the analysis.

The ANOVA generates a p-value which is compared with a standard significance level ($\alpha = 0.05$). If a p-value is below 0.05, there is sufficient evidence to conclude that the sample means are significantly different from each other. However, if a p-value is above 0.05, there is not sufficient evidence to conclude that the samples are significantly different from each other. The p-value is included in parentheses for all of the analytes mentioned below.

Table 5-5. Comparison of March 1994 Sampling Results to HDW Model.

Analyte	Overall Mean	
	March 1994 Sample Results	HDW Model
METALS	**μg/mL**	**μg/mL**
Aluminum	41.7	5.90×10^3
Calcium	1.71 (estimated)	250
Chromium	2.03	77.4
Iron	0.510 (estimated)	77.4
Lead	< 0.126	1.08
Mercury	< 0.005	5.62×10^{-3}
Sodium	2770	3.52×10^4
Zinc	0.299 (estimated)	28.24
ANIONS/CATIONS	**μg/mL**	**μg/mL**
Chloride	56.3	973.7
Fluoride	34.1 (estimated)	16.4
Hydroxide	< 125	1.66×10^4
Nitrate	1,560	4.51×10^4
Nitrite	1,010	2.31×10^3
Phosphate	92.7	955
Sulfate	201	1.97×10^3
RADIONUCLIDES	**μg/mL**	**μg/mL**
^{134}Cs	< 0.00149 (estimated)	36.6
^{137}Cs	4.29	
^{238}Pu	< 5.65E-04	1.32×10^{-2}
$^{239/240}Pu$	< 4.13E-04	
^{90}Sr	0.0772	16.4

Table 5-6. Comparison of Analytical Results for Tank 241-AP-108 to Tank 241-AP-106.[1]

Analyte	Overall Mean		Ratios AP-108/AP-106
METALS	**AP-108**	**μg/mL AP-106**	
Aluminum	1,070	211	5.07
Iron	< 5.05	6.89	0.73
Sodium	17,400	5,530	3.14
ANIONS	**μg/mL**		
Chloride	190	56.3	3.37
Fluoride	575	173	3.32
Hydroxide	2,770	1,430	1.94
Nitrate	14,800	4,230	3.49
Nitrite	3,730	1,160	3.21
Phosphate	299	211	1.42
Sulfate	515	140	3.68
RADIONUCLIDES	**μCi/mL**		
^{241}Am	< 2.18E-05	9.54E-05	4.31
^{137}Cs	19.5	4.57	4.27
^{60}Co	< 6.44E-04	< 1.92×10^{-3}	0.335
$^{239/240}Pu$	5.99E-05	1.36×10^{4}	0.07
$^{89/90}Sr$	0.0311	0.0007	---
CARBON	**μg C/mL**		
Total inorganic carbon	1,730	486	3.56
Total organic carbon	398	497	0.80
PHYSICAL PROPERTIES			
pH	13.2	12.9	1.02
Wt% water	93.0	100.2	0.93
Specific gravity	1.02	0.996	1.02

Note:

[1]Esch (1996)

The results of the ANOVA indicated that there were significant concentration differences between the two risers for 7 of the 15 analytes tested: sodium (0.002), chloride (0.038), fluoride (0.009), nitrate (0.020), phosphate (0.021), sulfate (0.002), and pH (0.001). The results for the other eight analytes indicated horizontal uniformity of the tank contents.

In summary, the visual descriptions of the samples and the Hanlon (1996) estimate indicated that the tank contents are fairly uniform, while the statistical results are inclusive. The decision was made to not require additional samples. The tank is 93% water, has no exotherms, and is an active tank.

5.4 COMPARISON OF TRANSFER HISTORY WITH ANALYTICAL RESULTS

The historical model (Agnew et al. 1996a) does not take into account tank transfers subsequent to January 1994. Because tank 241-AP-108 had many tank transfers after 1993, many of which are not well documented, a comparison of historical tank contents with the 1996 analytical results is not possible.

5.5 EVALUATION OF PROGRAM REQUIREMENTS

The two grab samples retrieved from tank 241-AP-108 in January of 1996 were taken to meet the requirements of the safety screening DQO (Dukelow et al. 1995) and the waste compatibility DQO (Fowler 1995). A discussion of the specific requirements of these DQOs and a comparison of the analytical results to defined concentration limits is presented in this section. Section 5.5.1 details the safety evaluations required by the two DQOs, and Section 5.5.2 details the pertinent operations decision rules specified in the waste compatibility DQO.

5.5.1 Safety Evaluation

Data criteria identified in the safety screening DQO are used to assess the safety of the tank waste and to check for unknown safety issues. The waste compatibility DQO establishes criteria to identify when waste transfers may cause safety problems. The set of primary safety analyses required by the two DQOs were similar. Both dictated analysis for energetics (by DSC) to evaluate the fuel content, although the specific limits set by the two DQOs differed. The safety screening DQO required determination of the LFL of the gases in the tank headspace, and total alpha activity to determine the criticality potential, while the waste compatibility DQO required a density determination to evaluate the potential for flammable gas accumulation within the waste. In addition, the waste compatibility DQO imposed waste composition limits on the tank contents to control corrosion. For each of the required analyses, a decision threshold was established by the DQOs which, if exceeded, may warrant further investigation to assure the safety of the tank. Tables 5-7 and 5-8 list the applicable safety issues, decision variables, and thresholds for the safety screening and waste compatibility DQOs, respectively, along with the mean analytical results from the 1996 grab sampling event.

The safety screening DQO has established a decision threshold of -480 J/g (dry weight basis) for the DSC analyses (Dukelow et al. 1995). The waste compatibility DQO threshold specifies that the absolute value of the exotherm/endotherm ratio must be < 1.0 for any transfer to be allowed. Since no exothermic reactions were noted in any of the samples, neither DQO limit was exceeded and the calculation of the 95 percent upper confidence limit per the safety screening DQO was unnecessary.

The potential for criticality can be assessed from the total alpha activity data. The safety screening DQO limit is 61.5 μCi/mL, and the Waste Compatibility Limit is $\leq$ 0.05 g/gal (0.812 μCi/mL). Total alpha activity was not detected in any of the samples. Statistical calculation of a 95 percent upper confidence limit was unnecessary.

Table 5-7. Decision Variables and Criteria for the Safety Screening Data Quality Objective.

Safety Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result
Ferrocyanide/ Organics	Total fuel content	-480 J/g	No exotherms
Criticality	Total alpha activity	1 g/L[1] (61.5 μCi/mL)	Not detected
Flammable gas	Flammable gas	$\leq$ 25% of the LFL	0 percent LFL

Note:

[1]Although the actual decision threshold listed in the DQO was 1 g/L, total alpha was measured in μCi/mL rather than g/L. To convert the threshold for total alpha into the same units as the laboratory, it was assumed that all alpha decay originated from ^{239}Pu . Using the specific activity of ^{239}Pu (0.0615 Ci/g), the threshold may be converted to 61.5 μCi/mL as shown:

$$\left(\frac{1\ \text{g}}{\text{L}}\right)\left(\frac{1\ \text{L}}{10^3\ \text{mL}}\right)\left(\frac{0.0615\ \text{Ci}}{1\ \text{g}}\right)\left(\frac{10^6\ \mu\text{Ci}}{1\ \text{Ci}}\right) = 61.5\ \frac{\mu\text{Ci}}{\text{mL}}.$$

Table 5-8. Safety Decision Variables and Criteria for the Waste Compatibility Data Quality Objective.

Safety Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result
Energetics	Total fuel content	< 1.0 exotherm/endotherm ratio	No exotherms
Organic layer	Organic layer	Presence of organic layer	No organic layer
Criticality	Total alpha activity (Pu)	< 0.05 g/gal (< 0.812 μCi/mL)[1]	Not detected
Flammable gas accumulation	Waste density	Density < 1.3 g/mL	1.02 g/mL
Corrosion	Concentration of nitrate, hydroxide, and nitrite	[2]$[NO_3^-] \leq 1.0$ M; and 0.01 M $\leq [OH^-] \leq 8.0$ M; and 0.011 M $\leq [NO_2^-] \leq 5.5$ M	$[NO_3^-] = 0.239$ M $[OH^-] = 0.163$ M $[NO_2^-] = 0.0811$ M

Notes:

[1]Although the actual decision criterion listed in the DQO was 0.05 g/gal, total alpha was measured in μCi/ml. To convert the notification limit for total alpha into the same units as those used by the laboratory, it was assumed that all alpha decay originated from ^{239}Pu . Using the specific activity of ^{239}Pu (0.0615 Ci/g), the decision criterion may be converted to 0.812 μCi/ml as shown:

$$\left(\frac{0.05\ g}{gal}\right)\left(\frac{1\ gal}{3{,}785\ mL}\right)\left(\frac{0.0615\ Ci}{1\ g}\right)\left(\frac{10^6\ \mu Ci}{1\ Ci}\right) = 0.0812\ \frac{\mu Ci}{mL}.$$

[2]These criteria apply for receiving tank operating temperatures of $\leq$ 75 °C (167 °F).

The flammability of the gas in the tank headspace is an additional safety screening DQO consideration. The criterion is that any flammable gas present must be $\leq$ 25 percent of the LFL. The analytical result was 0 percent of the LFL (see Section 4.1.3). The waste compatibility DQO flammable gas decision rule requires that the specific gravity of the waste be < 1.3 g/mL before any transfer is allowed. The analytical result of 1.02 g/mL was below this threshold.

The waste compatibility DQO also specifies three additional decision rules to be followed. The first of these specifies several waste composition limits to control corrosion; these are listed in Table 5-8. The analytical results from the 1996 grab samples for hydroxide, nitrate, and nitrite all met the criteria listed. Another decision rule states that no high-level waste will be accepted for transfer to a tank identified as a Watch List tank without Department of Energy approval. The final decision rule states that potential chemical compatibility hazards are to be identified prior to acceptance of waste into any double-shell tank, and the source wastes shall be categorized according to a compatibility matrix specified in Fowler (1995).

Another factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. The estimated tank heat load based on the 1996 data was 9.79 W (33.4 Btu/hr), well below the 20,500-W (70,000-Btu/hr) operating specification limit for the 241-AP tank farm (Harris 1994).

5.5.2 Operations Decision Rules Evaluation

The waste compatibility program requires a formal operations analysis of non-routine transfers before they are approved. Several criteria are applicable when evaluating the feasibility of a waste transfer between tanks: the segregation of TRU (transuranic) and non-TRU waste, heat generation, high-phosphate waste, waste pumpability, complexant waste segregation, and tank waste type. Three of these criteria are listed and compared to the analytical results in Table 5-9.

Table 5-9. Waste Compatibility Operations Decision Rules.

Operations Issue	Primary Decision Variable	Decision Criteria Threshold	Mean Analytical Result
Transuranics	TRU elements	[TRU] $\leq$ 0.1 μCi/g	8.01E-05 μCi/g
Heat load	Heat generation rate	$\leq$ 20,500 W (70,000 Btu/hr)	9.79 W (33.4 Btu/hr)
High phosphate waste	[PO_4^{-3}]	[PO_4^{-3}] < 0.1<u>M</u>	0.00315 <u>M</u>

The first criterion listed called for the segregation of TRU from non-TRU elements in the waste. If the TRU concentration in the tank is $\geq$ 0.1 μCi/g, then the waste must be transferred to a TRU storage tank only. The mean analytical result of 8.17E-05 μCi/mL (8.01E-05 μCi/g) was based on ^{241}Am and $^{239/240}$Pu, and was well below the TRU threshold.

The heat generation threshold depends on the operating specification document limit for a given tank. The heat generation limit for tank 241-AP-108 was, as mentioned in the previous section, 20,500 W (70,000 Btu/hr) (Harris 1994). The estimated tank heat load of 9.79 W (33.4 Btu/hr) was far below this limit.

High phosphate waste, defined as > 0.1 <u>M</u>, is not to be mixed with defined concentrations of certain other waste types. Because the phosphate concentration of tank 241-AP-108 was 0.00315 <u>M</u>, this issue was not a concern.

Three additional operations issues are not comparable to analytical results, and are thus outside the scope of this report. They are mentioned for informational purposes only. The first of these is that if a source waste stream is designated as complexant, then any waste transfer must be to a complexant waste receiver tank. Second, the tank waste types have been categorized according to a compatibility matrix, and all transfers must be in accordance with this matrix. Finally, the inputs to the waste pumpability issue are density, viscosity, and volume percent solids, along with the pipe diameter and pump velocity (Fowler 1995).

6.0 CONCLUSIONS AND RECOMMENDATIONS

The waste in tank 241-AP-108 was grab sampled in January 1996 for the purposes of safety screening and waste compatibility analyses. The DQOs governing this event were the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995) and the *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Fowler 1995). The safety issues evaluated by the two DQOs included energetics (to determine the fuel content), total alpha activity (to assess criticality), flammable gas concentration, and the potential for corrosion. All samples were analyzed at the Westinghouse 222-S Laboratory.

The analytical results for tank 241-AP-108, when compared to the limits established by the Safety Screening DQO, indicate that tank 241-AP-108 is safe.

Comparisons were made between the analytical results and the decision thresholds given in the safety screening and waste compatibility DQOs. All analytical results met their respective criteria. No exothermic reactions were observed in any of the samples. The overall mean for total alpha activity was < 7.15E-04 μCi/mL, well below the safety screening and waste compatibility threshold of 61.5 μCi/ml and 0.812 μCi/ml, respectively. The flammable gas concentration in the tank headspace was 0 percent of the LFL, and the specific gravity mean of 1.02 g/mL was well below the waste compatibility limit of 1.3 g/mL for the flammable gas accumulation issue. Finally, the concentrations of hydroxide, nitrate, and nitrite were all within their prescribed corrosion specifications.

The waste compatibility DQO also requires an operations analysis of non-routine transfers before they are approved. Several decision criteria apply, and all of the analytical results met those criteria. The concentration of TRU elements in the tank (8.01E-05 μCi/g) was below the threshold of 0.1 μCi/g, indicating that any transfer would not necessarily have to be to a TRU tank only. Concerns about the mixing of high-phosphate waste with certain other waste types was not an issue because the phosphate analytical result of 0.00315 $\underline{M}$ was well below the high phosphate threshold of > 0.1 $\underline{M}$. The estimate of the tank heat load based on the 1996 analytical results is 9.79 W (33.4 Btu/hr). The three remaining operations decision rules require information or data inputs outside the scope of this report, and are specified in Fowler (1995).

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APPENDIX A

ANALYTICAL RESULTS FROM 1996 GRAB SAMPLING

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A.0 ANALYTICAL RESULTS FROM 1996 GRAB SAMPLING

A.1 INTRODUCTION

Appendix A reports the chemical, radiochemical and physical characteristics of tank 241-AP-108 in table form and in terms of the specific concentrations of metals, ions, radionuclides, and physical properties.

Each data table lists the following: laboratory sample identification, sample origin (riser/degrees), an original and duplicate result for each sample, a sample mean, a mean for the tank in which both riser means are weighted equally, a relative standard deviation of the mean (RSD [mean]), and a projected tank inventory for the particular analyte using the weighted mean and the appropriate conversion factors. The projected tank inventory column is not applicable to the pH, percent water, DSC, or specific gravity data. The data are listed in standard notation for values greater than 0.001 and less than 100,000. Values outside these limits are listed in scientific notation.

The tables are numbered A-1 through A-22. A description of the units and symbols used in the analyte tables and the references used in compiling the analytical data (Esch 1996) are found in the List of Terms and Section 7.0, respectively. For information on sampling rationale, locations, and descriptions of sampling events, see Section 3.0.

A.2 ANALYTE TABLE DESCRIPTION

The "Sample Number" column lists the laboratory sample for which the analyte was measured.

Column two specifies the riser location from which each sample was derived.

The Result and Duplicate columns are self-explanatory. The "Sample Mean" column is the average of the result and duplicate values. All values, including those below the detection level (indicated by the less-than symbol, <), were averaged in calculating the sample means. If the result and duplicate values were both nondetected, the mean is expressed as a nondetected value. On the other hand, if both are detected, then the sample mean is reported as a detected value. The result and duplicate values, as well as the result/duplicate means, are reported in the tables exactly as found in the original laboratory data package. The means may appear to have been rounded up in some cases and rounded down in others; this is because the analytical results given in the tables may have fewer significant figures than originally reported, not because the means were incorrectly calculated.

The overall (or analyte concentration) means for the waste in tank 241-AP-108 were calculated by averaging the two riser means.

The RSD (mean) in percent is 100 times the standard deviation of the mean divided by the overall tank mean. The standard deviation of the mean was estimated using standard ANOVA statistical techniques. Relative standard deviations of the mean were computed only for analytes that had nondetected values.

The projected inventory is the product of the overall analyte concentration mean, the volume of tank waste (106 kL), and the appropriate conversion factors.

The four QC parameters assessed on the tank 241-AP-108 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. These were summarized in Section 5.1.2, and more specific information is provided in the following appendix tables. Sample and duplicate pairs in which any of the QC parameters were outside their specified limits are noted with a superscript in column 5 as follows:

QC:1 -- indicates that the standard recovery was below the QC range.
QC:2 -- indicates that the standard recovery was above the QC range.
QC:3 -- indicates that the spike recovery was below the QC range.
QC:4 -- indicates that the spike recovery was above the QC range.
QC:5 -- indicates that the RPD was greater than the QC limit range.
QC:6 -- indicates that there was blank contamination.

Table A-1. Tank 241-AP-108 Analytical Results: Aluminum.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	1,090	1,090	1,090	1,070	1.9	113
S96T000090	Riser 1@30°	1,050	1,050	1,050			

Table A-2. Tank 241-AP-108 Analytical Results: Iron.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	< 5.050	< 5.05	< 5.05	< 5.05	N/A	< 0.535
S96T000090	Riser 1@30°	< 5.050	< 5.05	< 5.05			

Table A-3. Tank 241-AP-108 Analytical Results: Sodium.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	18,000	18,000	18,000	17,400	3.6	1,840
S96T000090	Riser 1@30°	16,700	16,800	16,800[QC:4]			

Table A-4. Tank 241-AP-108 Analytical Results: Chloride.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	210	210.0	210.2	190	10.5	20.1
S96T000090	Riser 1@30°	178	162.0	169.8			

Table A-5. Tank 241-AP-108 Analytical Results: Fluoride.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	597	607.0	602.0	575	4.7	61.0
S96T000090	Riser 1@30°	550	547.0	548.6			

Table A-6. Tank 241-AP-108 Analytical Results: Hydroxide.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	2,810	2,690	2,750	2,770	0.5	294
S96T000090	Riser 1@30°	2,760	2,790	2,780			

Table A-7. Tank 241-AP-108 Analytical Results: Nitrate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	14,600	14,600	14,600	14,800	1.2	1,570
S96T000090	Riser 1@30°	15,000	14,900	15,000			

Table A-8. Tank 241-AP-108 Analytical Results: Nitrite.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	3,650	3,830	3,740	3,730	0.3	395
S96T000090	Riser 1@30°	3,740	3,690	3,710			

Table A-9. Tank 241-AP-108 Analytical Results: Phosphate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000097	Riser 1@150°	344	366.0	355.1	299	18.8	31.7
S96T000090	Riser 1@30°	255	230.0	242.6			

Table A-10. Tank 241-AP-108 Analytical Results: Sulfate.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000097	Riser 1@150°	611	628.0	619.5	515	20.3	54.6
S96T000090	Riser 1@30°	406	414.0	409.9			

Table A-11. Tank 241-AP-108 Analytical Results: Americium-241.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		**µCi/mL**	**µCi/mL**	**µCi/mL**	**µCi/mL**	**%**	**Ci**
S96T000098	Riser 1@150°	< 2.05E-05	< 2.06E-05	< 2.06E-05	< 2.18E-05	N/A	< 0.00231
S96T000092	Riser 1@30°	< 2.34E-05	< 2.23E-05	< 2.29E-05			

Table A-12. Tank 241-AP-108 Analytical Results: Cesium-137.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		**µCi/mL**	**µCi/mL**	**µCi/mL**	**µCi/mL**	**%**	**Ci**
S96T000098	Riser 1@150°	19.41	19.90	19.66	19.5	0.8	2,070
S96T000092	Riser 1@30°	19.61	19.10	19.36			

Table A-13. Tank 241-AP-108 Analytical Results: Cobalt-60.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96T000098	Riser 1@150°	< 6.82E-04	< 6.55E-04	< 6.69E-04	< 6.44E-04	N/A	< 0.0683
S96T000092	Riser 1@30°	< 6.33E-04	< 6.02E-04	< 6.18E-04			

Table A-14. Tank 241-AP-108 Analytical Results: Plutonium-239/240.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96T000098	Riser 1@150°	6.15E-05	5.880E-05	6.010E-05	5.99E-05	0.4	0.00635
S96T000092	Riser 1@30°	5.91E-05	6.030E-05	5.970E-05			

Table A-15. Tank 241-AP-108 Analytical Results: Strontium-89/90.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96T000098	Riser 1@150°	0.0393	0.02870	0.03400[QC:5]	0.0311	9.4	3.30
S96T000092	Riser 1@30°	0.0288	0.02750	0.02820			

Table A-16. Tank 241-AP-108 Analytical Results: Total Alpha.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µCi/mL	µCi/mL	µCi/mL	µCi/mL	%	Ci
S96T000098	Riser 1@150°	< 6.67E-04	< 9.84E-04	< 8.26E-04	< 7.15E-04	N/A	< 0.0758
S96T000092	Riser 1@30°	< 6.03E-04	< 6.03E-04	< 6.03E-04			

Table A-17. Tank 241-AP-108 Analytical Results: TIC.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg C/mL	µg C/mL	µg C/mL	µg C/mL	%	kg C
S96T000097	Riser 1@150°	1,740	N/A	1,740	1,730	0.4	183
S96T000090	Riser 1@30°	1,720	1,730	1,720			

Table A-18. Tank 241-AP-108 Analytical Results: TOC.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)	Projected Inventory
Liquids		µg C/mL	µg C/mL	µg C/mL	µg C/mL	%	kg C
S96T000097	Riser 1@150°	399	N/A	399	398	0.2	42.2
S96T000090	Riser 1@30°	387	407	397			

Table A-19. Tank 241-AP-108 Analytical Results: pH.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)
Liquids		unitless	unitless	unitless	unitless	%
S96T000097	Riser 1@150°	13.02	13.04	13.03	13.2	1.1
S96T000090	Riser 1@30°	13.33	13.32	13.32		

Table A-20. Tank 241-AP-108 Analytical Results: Percent Water by TGA.

Sample Number	Sample Location	Result		Duplicate		Sample Mean	Overall Mean	RSD (mean)
Liquids		% H_2O	Temperature Range (°C)	% H_2O	Temperature Range (°C)	% H_2O	% H_2O	%
S96T000097	Riser 1@150°	93.43	31.7 - 137	93.19	29.5 - 140	93.31	93.0	0.3
S96T000090	Riser 1@30°	93.22	26.2 - 142	92.31	26.6 - 147	92.77		

Table A-21. Tank 241-AP-108 Analytical Results: Energetics by DSC.

Sample Number	Sample Location	Run	Sample Weight	Transition 1	
Liquids			mg	Peak Temp. (°C)	ΔH (J/g)
S96T000097	Riser 1@150°	1	10.85	110	2,161
		2	10.45	109	2,035
S96T000090	Riser 1@30°	1	18.69	113	2,167
		2	19.81	114	2,053

Note:
ΔH = change in enthalpy (negative sign denotes exothermic reaction)

Table A-22. Tank 241-AP-108 Analytical Results: Specific Gravity.

Sample Number	Sample Location	Result	Duplicate	Sample Mean	Overall Mean	RSD (mean)
Liquids		unitless	unitless	unitless	unitless	%
S96T000097	Riser 1@150°	1.023	1.020	1.022	1.02	0.2
S96T000090	Riser 1@30°	1.025	1.018	1.022		

APPENDIX B

HISTORICAL SAMPLING EVENT

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B.0 ANALYTICAL RESULTS FROM 1994 GRAB SAMPLING EVENT

Table B-1 lists the analytical results from the March 1994 historical sampling event. The tank contents have changed considerably since that time, and the data are presented for informational purposes only. A more detailed description of the sampling can be found in Section 3.4.

Table B-1. March 1994 Sampling Results for Tank 241-AP-108.[1] (2 sheets)

Analyte	Overall Mean
METALS	**μg/mL**
Aluminum	41.7
Arsenic	< 0.0322
Barium	< 0.0200
Cadmium	0.141
Calcium	1.71 (estimated)
Chromium	2.03
Iron	0.510 (estimated)
Lead	< 0.126
Magnesium	0.0870 (estimated)
Manganese	< 0.0180
Mercury	< 0.005
Selenium	< 0.0130
Silver	0.0632
Sodium	2770
Uranium	13.5
Zinc	0.299 (estimated)
ANIONS/CATIONS	**μg/mL**
Ammonia	8.2 (estimated)
Carbonate	486
Chloride	56.3
Cyanide	< 0.45
Fluoride	34.1 (estimated)
Hydroxide	< 125
Nitrate	1,560

Table B-1. March 1994 Sampling Results for Tank 241-AP-108.[1] (2 sheets)

Analyte	Overall Mean
ANIONS/CATIONS (cont'd)	**μg/mL**
Nitrite	1,010
Phosphate	92.7
Sulfate	201
RADIONUCLIDES	**μCi/mL**
^{241}Am	< 2.87E-04
^{14}C	< 2.19E-06
^{144}Ce/Pr	< 0.00904
^{134}Cs	< 0.00149 (estimated)
^{137}Cs	4.29
^{60}Co	< 2.02E-04
$^{243/244}$Cm	< 2.87E-04
^{154}Eu	< 9.01E-04
^{155}Eu	< 0.00487
^{129}I	< 6.30E-05
^{237}Np	< 1.64E-04
^{94}Nb	< 4.81E-04
^{238}Pu	< 5.65E-04
$^{239/240}$Pu	< 4.13E-04
^{226}Ra	< 0.0374
^{106}Ru/Rh	< 0.0272
^{79}Se	< 1.21E-05
^{90}Sr	0.0772
^{99}Tc	0.000308
^{3}H	0.0112
Total alpha	2.93E-04 (estimated)
Total beta	6.18
PHYSICAL PROPERTIES	
Specific gravity	0.988

Note:

[1]Miller (1994)

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G. Jansen	H6-33	X			
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